I claim:

1. In apparatus for irradiating a selected region of a target material containing a radiationally excitable species in order to excite members of said species, including a source of exciting radiation adapted to excite said members and focusing means to focus said radiation to a pattern having a central maximum at said selected region, a method of increasing the resolution of said apparatus including the steps of:

providing quenching radiation adapted to radiationally quench the excitation of said members; and

applying said quenching radiation to said selected region to preferentially decrease the excitation in a chosen part of said region, thereby increasing the resolution of said apparatus.

2. The method of Claim 1 and including the additional step of shaping the quenching radiation to a pattern with a central minimum.

3. The method of Claim 2 and including the additional step of making the central minumum substantially coincident with the central maximum of exciting radiation.

4. The method of Claim 2 including the additional steps of:

providing at least two sources of coherent quenching radiation; and

focusing radiation from at least two of these sources onto the target material so the quenching radiation arriving at the selected region from one of these sources is out-of-phase with respect to radiation from the other source.

5. The method of Claim 4 and including at least one additional source of quenching radiation focused onto the target material, and including an additional step insuring that in the selected region radiation from the sources of quenching radiation of Claim 24 and radiation from this additional source of radiation substantially do not interfere.

6. The method of Claim 5 wherein the step insuring that that the radiation from this additional source of quenching radiation substantially does not interefere with radiation from the quenching radiation sources of Claim 4 includes the steps of:

providing that the quenching radiation from the sources of Claim 4 is emitted in synchronous pulses: and

providing that radiation from said additional source is emitted in pulses which arrive at the target material at substantially different times than the pulses from the sources of Claim 4.

7. The method of Claim 5 wherein the step insuring that that the radiation from said additional source of quenching radiation substantially does not interfere with radiation from the quenching radiation sources of Claim 4 includes the step of focusing said additional source of radiation onto said selected region so that in said selected region the phase difference between it and the quenching radiation from said sources of Claim 4 is in the class including substantially 60°, 90°, 120°, 240°, 270° and 320°.

8. The method of Claim 2, wherein said step shaping said quenching radiation into a pattern with a central minimum includes the step of passing said quenching radiation through a plurality of optical fibers, each of said fibers having an exit end where the quenching radiation exits the fiber, such that said exit ends are spaced from an optical axis.

9. The method of Claim 1, including the additional step of passing said quenching radiation through said focusing means.

10. The method of Claim 6, and including the additional step providing that radiation from the sources of Claim 4 and the radiation from said additional sources are focused at different depths in said target material.

11. The method of Claim 1, including the additional steps of:

delivering said exciting radiation in pulses; and

delivering said quenching radiation in pulses which begin after the initiation of said pulses of exciting radiation.

12. The method of Claim 1 wherein said radiationally excitable species are in a class including:

fluorescent molecules in a target material to be examined;

molecules in a target material consisting of a recording medium encoding information; and

molecules in a photolithographic resist.

13. The method of Claim 1 wherein said apparatus is adapted to simultaneously irradiate a plurality of non-adjacent regions in said target material with exciting radiation, forming in each said region a central maximum of exciting radiation, and for each of said irradiated regions, to direct said quenching radiation so that a central minimum of quenching radiation overlaps with the central maximum in the region, thereby simultaneously improving the resolution for each of the irradiated regions.

14. The method of Claim 1, and including an additional steps of measuring radiation emitted by the irradiated portion of said material and

substantially preventing quenching radiation from being included in the measurement of the radiation emitted by the irradiated portion of said material.

15. The method of Claim 14 wherein said measuring step uses a radiation detector and wherein said additional step for substantially preventing quenching radiation from being included in the measurement includes the use of an optical filter substantially opaque to said quenching radiation, said filter being located in the optical path between said specimen and said radiation detector.

16. The method of Claim 14 including the additional step of delivering said exciting radiation in short pulses and delivering said quenching radiation in short pulses of quenching radiation which follow said pulses of exciting radiation, and wherein said additional step for substantially preventing quenching radiation from being included in the measurement includes a step of gating the measurement off during said short pulses of quenching radiation.

17. The method of Claim 1, wherein said species has an excitation spectrum with at least one band where radiation of a wavelength within said band produces substantially no excitation of said species, and including the step of substantially preventing the quenching radiation from exciting said members by the step of providing the quenching radiation of a wavelength within said band.

18. The method of Claim 1 wherein said exciting radiation excites members of said species by a two-photon process and wherein said quenching radiation quenches said members by a one-photon process.

19. In apparatus for irradiating a selected region of a target material containing a radiationally excitable species in order to excite members of said species, including a source of exciting radiation adapted to excite said members and focusing means to focus said radiation to a pattern having a central maximum at said selected region, mean of increasing the resolution of said apparatus including:

means for providing quenching radiation adapted to radiationally quench the excitation of said members; and

means for directing said quenching radiation to said selected region so as to preferentially decrease the excitation in a chosen part of said region, thereby increasing the resolution of said apparatus.

20. In apparatus for irradiating a selected region of a target material containing a radiationally excitable species in order to excite members of said species, including a source of exciting radiation adapted to excite said members and focusing means to focus said radiation to a pattern in a focal plane at said material, said pattern having a central maximum, means for increasing the effective resolution of said focusing means including:

means for providing quenching radiation adapted to radiationally quench the excitation of said members;

means for shaping said quenching radiation into a pattern with a central minimum, whereby within the central minimum, the intensity of quenching radiation increases with distance from the center of the central minimum; and

means for overlapping said central minimum with said central maximum, whereby, within said central minimum, an excited member of said species is quenched by said quenching radiation with a probability which increases with the distance of said member from the center of said central maximum.

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